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Introduction

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Visiting a typical late twentieth century university, you would find people in the mathematics department who studied the mathematical structure of inference and definition, and in the psychology department you would find people studying the human practice of reasoning and representation. Not many people climbed the fence between the mathematicians and the psychologists. But fences have invited peeping all through history, both in world literature and in reality. Contacts between mathematics, logic, psychology, philosophy and linguistics go back a long way and in recent years they have intensified, taking on board computer science too. There is now a growing body of substantial research on human reasoning with contributions from all these disciplines.

The aim of this issue is to show by example what the current interface of logic and psychology looks like, in the hands of some of its best practitioners.

Broadly speaking, each of the nine papers in this collection addresses some crucial human cognitive ability, ranging from classics such as language interpretation, number sense, and logical inference, to more modern themes such as belief change and interactive communication. Moreover, these themes are approached in a variety of ways.

Psychologists study behaviour directly, often by controlled experiments, and many of the papers report on that. But we can also look for other levels of description for homo sapiens. Nowadays, we can make brain scans of people while they carry out certain tasks; we can see how people behave when their brains are in some way defective; and we can analyse how the relevant thinking is emulated in a neural net. Alternatively we can model behaviour at a much more abstract level, by showing that it follows norms of rationality, given the concepts and the goals involved. Logic comes in here, with techniques that range from truth tables to games. The papers in this volume illustrate all these levels, where the highly abstract can meet the very concrete in surprising ways, as in the recent discovery that so-called default logics match neural nets.

Turning to the specific cognitive processes represented here, Cowles et al. investigate some classical linguistic mechanisms (topic and focus) involved in understanding who or what is being referred to, and hence the textual coherence needed for successful language interpretation. Knauff studies a wide variety of standard patterns of logical inference, taking the topic much deeper into brain research than would have seemed possible a few years ago, and shows how making inferences involves language, vision and other modules in the brain. Next, Garcez et al. discuss possible neural mechanisms to support a broader range of inferential procedures, viz. deduction, induction and abduction. Clark and Grossman study the prerequisites of computation, another classic cognitive skill, combining logic and experimental work in a resourceful way to conclude that number sense is not built on our

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understanding of language. And while these three activities may be thought of as involving just a single agent, Benz and van Rooij analyse a typical interactive cognitive skill, viz. optimal communicative behaviour among several agents in cooperative dialogue.

One pervading theme in studies of human reasoning, both classical and modern, is that of conditional sentences, using the word 'if'. Quite a few papers in this collection show that these sentences continue to provide new cognitive questions and new insights. Politzer gives an overall assessment of the state of the art in cognitive studies of conditional sentences, and suggests new directions in thinking about their modelling. Stenning and van Lambalgen present a logical analysis of the steps needed in reasoning with conditionals, and use this as a tool for uncovering brain mechanisms, with applications to understanding brain disorders. Leitgeb raises the fundamental question what state of mind constitutes a ''conditional belief'', drawing on philosophical epistemology. And finally, it has long been acknowledged that conditionals encode tendencies to revise our beliefs, when presented with new information. Castelfranchi and Lorini analyse the notion of surprise, its role as a trigger for belief change, and the logical representations that best account for this essential cognitive process that keeps us attuned to the world, and interactive with other human beings.

Clearly these papers are the beginning of a tale. Each of them separately opens up a larger research area, and viewing them together suggests new research connections. There are many further shared topics between logic and psychology that might have been included—for example speaker's meaning versus hearer's meaning, or the spatial and temporal reasoning that keep us oriented in this physical world, or the fast-growing modern research on learning mechanisms. But we have already strained the bounds of a single *Topoi* volume—we thank Fabio Paglieri for his patience. We are deeply grateful to our authors for their enthusiastic cooperation.